

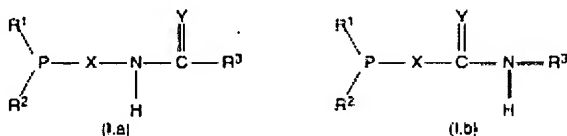
A P P E N D I X I:

CLAIM AMENDMENTS:

Amend Claims 5, 7, 10 and 11, and enter new Claim 21 as indicated in the following listing of the claims:

1. (*original*) A process for hydroformylating compounds which contain at least one ethylenically unsaturated double bond by reacting with carbon monoxide and hydrogen in the presence of a catalyst comprising at least one complex of a metal of transition group VIII of the Periodic Table of the Elements with ligands which each have a phosphorus group and at least one functional group which is capable of forming intermolecular noncovalent bonds, wherein the complex has ligands which are dimerized via intermolecular noncovalent bonds and wherein the distance between the phosphorus atoms of the dimerized ligands is at most 5 Å.
2. (*previously presented*) A process as claimed in claim 1, wherein the distance between the phosphorus atoms of the dimerized ligands is in the range from 2.5 to 4.5 Å.
3. (*previously presented*) A process as claimed in claim 1, wherein the functional groups which are capable of forming intermolecular noncovalent bonds are selected from hydroxyl, primary, secondary and tertiary amino, thiol, keto, thioketone, imine, carboxylic ester, carboxamide, amidine, urethane, urea, sulfoxide, sulfoximine, sulfonamide and sulfonic ester groups.
4. (*previously presented*) A process as claimed in claim 1, wherein the functional groups which are capable of forming intermolecular noncovalent bonds are selected from groups which are capable of tautomerizing.
5. (*currently amended*) A process ~~as claimed in claim 1~~ for hydroformylating compounds which contain at least one ethylenically unsaturated double bond by reacting with carbon monoxide and hydrogen in the presence of a catalyst comprising at least one complex of a metal of transition group VIII of the Periodic Table of the Elements with ligands which each have a phosphorus group and at least one functional group which is capable of forming intermolecular noncovalent bonds, wherein the complex has ligands which are dimerized via intermolecular noncovalent bonds and wherein the distance between the phosphorus atoms of the dimerized ligands is at most 5 Å, and wherein the

ligands include at least one structural element of the general formulae I.a or I.b



or tautomers thereof where

R<sup>1</sup> and R<sup>2</sup> are each independently alkyl, alkoxy, cycloalkyl, cycloalkoxy, heterocycloalkyl, heterocycloalkoxy, aryl, aryloxy, hetaryl or hetaryloxy,

R<sup>3</sup> is hydrogen or is as defined for R<sup>1</sup> and R<sup>2</sup>,

X is a bivalent bridging group having from 1 to 5 bridging atoms between the flanking bonds,

Y is O, S or NR<sup>4</sup>, where R<sup>4</sup> is hydrogen, alkyl, cycloalkyl, heterocycloalkyl, aryl or hetaryl,

and two or more than two of the X radicals and R<sup>1</sup> to R<sup>4</sup> together with the structural element of the formula I.a or I.b to which they are bonded may be a mono- or polycyclic compound.

6. (original) A process as claimed in claim 5, wherein R<sup>1</sup> and R<sup>2</sup> in the ligands I.a or I.b, together with the phosphorus atom to which they are bonded, are each a 5- to 8-membered heterocycle which may optionally additionally be singly, doubly or triply fused with cycloalkyl, heterocycloalkyl, aryl or hetaryl, and the heterocycle and, where present, the fused groups may each independently bear one, two, three or four substituents which are selected from alkyl, cycloalkyl, heterocycloalkyl, aryl, hetaryl, COOR<sup>c</sup>, COO<sup>-</sup>M<sup>+</sup>, SO<sub>3</sub>R<sup>c</sup>, SO<sub>3</sub><sup>-</sup>M<sup>+</sup>, PO<sub>3</sub>(R<sup>c</sup>)(R<sup>d</sup>), (PO<sub>3</sub>)<sup>2-</sup>(M<sup>+</sup>)<sub>2</sub>, NE<sup>4</sup>E<sup>5</sup>, (NE<sup>4</sup>E<sup>5</sup>E<sup>6</sup>)<sup>+</sup>X<sup>-</sup>, OR<sup>e</sup>, SR<sup>e</sup>, (CHR<sup>f</sup>CH<sub>2</sub>O)<sub>y</sub>R<sup>e</sup>, (CH<sub>2</sub>NE<sup>4</sup>)<sub>y</sub>R<sup>e</sup>, (CH<sub>2</sub>CH<sub>2</sub>NE<sup>4</sup>)<sub>y</sub>R<sup>e</sup>, halogen, nitro, acyl and cyano, where

R<sup>c</sup> and R<sup>d</sup> are each identical or different radicals selected from alkyl, cycloalkyl, aryl and hetaryl,

R<sup>e</sup>, E<sup>4</sup>, E<sup>5</sup>, E<sup>6</sup> are each identical or different radicals selected from hydrogen, alkyl, cycloalkyl, acyl, aryl and hetaryl,

R<sup>f</sup> is hydrogen, methyl or ethyl,

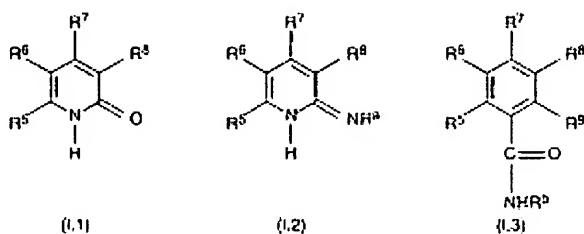
M<sup>+</sup> is one cation equivalent,

X<sup>-</sup> is one anion equivalent and

y is an integer from 1 to 240.

7. (currently amended) A process ~~as claimed in claim 1~~ for hydroformylating compounds which contain at least one ethylenically unsaturated double bond by reacting with carbon

monoxide and hydrogen in the presence of a catalyst comprising at least one complex of a metal of transition group VIII of the Periodic Table of the Elements with ligands which each have a phosphorus group and at least one functional group which is capable of forming intermolecular noncovalent bonds, wherein the complex has ligands which are dimerized via intermolecular noncovalent bonds and wherein the distance between the phosphorus atoms of the dimerized ligands is at most 5 Å, and wherein the ligands are selected from compounds of the general formulae I.1 to I.3



and the tautomers thereof where

one of the  $R^5$  to  $R^9$  radicals is a group of the formula  $-W'-PR^1R^2$  where

$W'$  is a single bond, a heteroatom, a heteroatom-containing group or a bivalent bridging group having from 1 to 4 bridging atoms between the flanking bonds,

$R^1$  and  $R^2$  are each independently alkyl, alkoxy, cycloalkyl, cycloalkoxy, heterocycloalkyl, heterocycloalkoxy, aryl, aryloxy, hetaryl or hetaryloxy,

the  $R^5$  to  $R^9$  radicals which are not  $-W'-PR^1R^2$  are each independently hydrogen, alkyl, cycloalkyl, heterocycloalkyl, aryl, hetaryl,  $WCOOR^0$ ,  $WCOO^+M^+$ ,  $W(SO_3)R^0$ ,  $W(SO_3)^+M^+$ ,  $WPO_3(R^0)(R^p)$ ,  $W(PO_3)^{2-}(M^+)_2$ ,  $WNE^1E^2$ ,  $W(NE^1E^2E^3)^+X^-$ ,  $WOR^q$ ,  $WSR^q$ ,  $(CHR^fCH_2O)_xR^q$ ,  $(CH_2NE^1)_xR^q$ ,  $(CH_2CH_2NE^1)_xR^q$ , halogen, nitro, acyl or cyano,

where

$W$  is a single bond, a heteroatom, a heteroatom-containing group or a bivalent bridging group having from 1 to 20 bridging atoms,

$R^0$  and  $R^p$  are each identical or different radicals selected from alkyl, cycloalkyl, aryl and hetaryl,

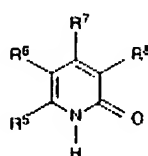
$R^q$ ,  $E^1$ ,  $E^2$ ,  $E^3$  are each identical or different radicals selected from hydrogen, alkyl, cycloalkyl, acyl, aryl and hetaryl,

$R^f$  is hydrogen, methyl or ethyl,

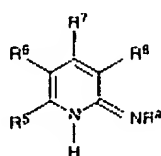
$M^+$  is one cation equivalent,

$X^-$  is one anion equivalent and  
 $x$  is an integer from 1 to 240,  
 and in each case two adjacent  $R^5$ ,  $R^6$ ,  $R^7$ ,  $R^8$  and  $R^9$  radicals,  
 together with the ring carbon atoms to which they are bonded, may  
 also be a fused ring system having 1, 2 or 3 further rings, and  
 $R^a$  and  $R^b$  are each hydrogen, alkyl, acyl, cycloalkyl,  
 heterocycloalkyl, aryl or hetaryl.

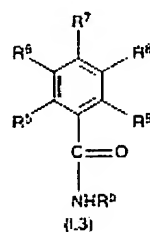
8. (previously presented) A process for hydroformylating compounds which  
 contain at least one ethylenically unsaturated double bond by  
 reacting with carbon monoxide and hydrogen in the presence of a  
 catalyst comprising at least one complex of a metal of transition  
 group VIII of the Periodic Table of the Elements with ligands  
 which are selected from compounds of the general formulae I.1 to  
 I.3



(I.1)



(I.2)



(I.3)

and the tautomers thereof where

one of the  $R^5$  to  $R^9$  radicals is a group of the formula  $-W'-PR^1R^2$   
 where

$W'$  is a single bond, a heteroatom, a heteroatom-containing group  
 or a bivalent bridging group having from 1 to 4 bridging atoms  
 between the flanking bonds,

$R^1$  and  $R^2$  are each independently alkyl, alkoxy, cycloalkyl,  
 cycloalkoxy, heterocycloalkyl, heterocycloalkoxy, aryl,  
 aryloxy, hetaryl or hetaryloxy,

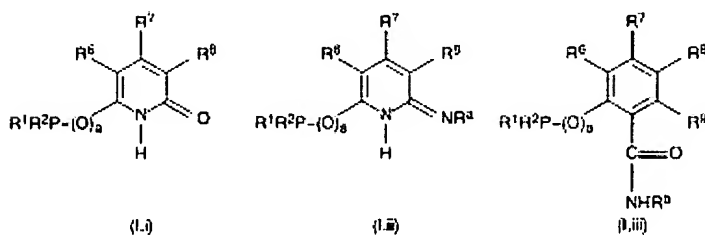
the  $R^5$  to  $R^9$  radicals which are not  $-W'-PR^1R^2$  are each independently  
 hydrogen, alkyl, cycloalkyl, heterocycloalkyl, aryl, hetaryl,  
 $WCOOR^0$ ,  $WCOO^+M^+$ ,  $W(SO_3)R^0$ ,  $W(SO_3)^+M^+$ ,  $WPO_3(R^0)(R^p)$ ,  $W(PO_3)^{2-}(M^+)_2$ ,  
 $WNE^1E^2$ ,  $W(NE^1E^2E^3)^+X^-$ ,  $WOR^q$ ,  $WSR^q$ ,  $(CHR^rCH_2O)_xR^q$ ,  $(CH_2NE^1)_xR^q$ ,  
 $(CH_2CH_2NE^1)_xR^q$ , halogen, nitro, acyl or cyano,

where

$W$  is a single bond, a heteroatom, a heteroatom-containing group  
 or a bivalent bridging group having from 1 to 20 bridging  
 atoms,

$R^o$  and  $R^p$  are each identical or different radicals selected from alkyl, cycloalkyl, aryl and hetaryl,  
 $R^q$ ,  $E^1$ ,  $E^2$ ,  $E^3$  are each identical or different radicals selected from hydrogen, alkyl, cycloalkyl, acyl, aryl and hetaryl,  
 $R^f$  is hydrogen, methyl or ethyl,  
 $M^+$  is one cation equivalent,  
 $X^-$  is one anion equivalent and  
 $x$  is an integer from 1 to 240,  
 and in each case two adjacent  $R^5$ ,  $R^6$ ,  $R^7$ ,  $R^8$  and  $R^9$  radicals, together with the ring carbon atoms to which they are bonded, may also be a fused ring system having 1, 2 or 3 further rings, and  
 $R^a$  and  $R^b$  are each hydrogen, alkyl, acyl, cycloalkyl, heterocycloalkyl, aryl or hetaryl.

9. (previously presented) A process as claimed in claim 6, wherein the ligands are selected from compounds of the general formulae I.i to I.iii



and the tautomers thereof where

$a$  is 0 or 1,

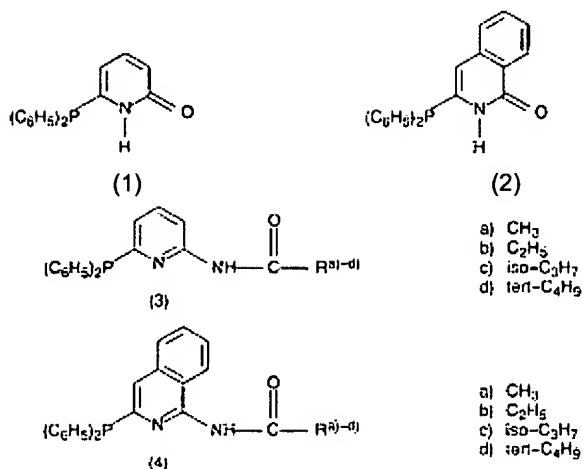
$R^1$  and  $R^2$  are each as defined above,

$R^6$  to  $R^9$  are each independently hydrogen,  $C_1$ - $C_4$ -alkyl,  $C_1$ - $C_4$ -alkoxy, acyl, aryl, heteroaryl, halogen,  $C_1$ - $C_4$ -alkoxycarbonyl or carboxylate,

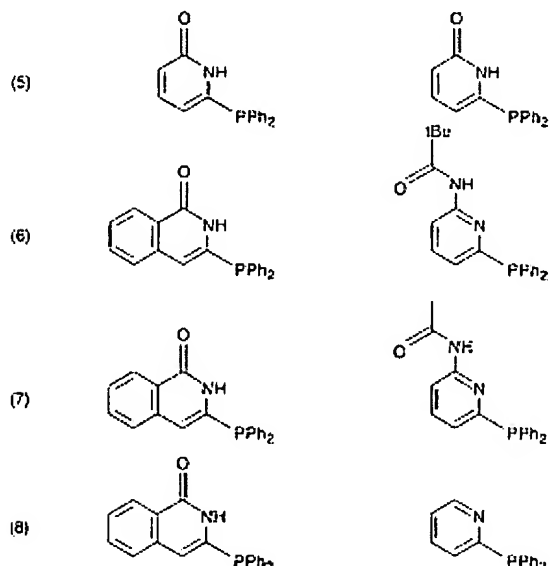
and in each case two adjacent  $R^6$ ,  $R^7$ ,  $R^8$  and  $R^9$  radicals, together with the ring carbon atoms to which they are bonded, may also be a fused ring system having 1, 2 or 3 further rings, and

$R^a$  and  $R^b$  are each hydrogen, alkyl, acyl, cycloalkyl or aryl.

10. (currently amended) A process as claimed in claim ~~1~~ 8, wherein the ligands used comprise at least one compound of the formulae (1) to (4)



11. (currently amended) A process as claimed in claim 1, wherein the ligand used is one of the following ligands/ligand pairs (5) to (8):



12. (previously presented) A catalyst as defined in claim 1.

13. (original) A catalyst as claimed in claim 12, wherein the metal is selected from cobalt, nickel, rhodium, ruthenium and iridium.

14. (canceled)

15. (canceled)

16. (canceled)

17. (previously presented) A process as claimed in claim 2, wherein the distance is in the range from 3.5 to 4.2 Å.

18. (previously presented) A process as claimed in claim 2, wherein the distance is in the range from 3.6 to 4.1 Å.

19. (previously presented) A process as claimed in claim 7, wherein  $R^1$  and  $R^2$ , together with the phosphorus atom to which they are bonded, are each a 5- to 8-membered heterocycle which may optionally additionally be singly, doubly or triply fused with cycloalkyl, heterocycloalkyl, aryl or hetaryl, and the heterocycle and, where present, the fused groups may each independently bear one, two, three or four substituents which are selected from alkyl, cycloalkyl, heterocycloalkyl, aryl, hetaryl,  $\text{COOR}^c$ ,  $\text{COO}^-\text{M}^+$ ,  $\text{SO}_3\text{R}^c$ ,  $\text{SO}_3^-\text{M}^+$ ,  $\text{PO}_3(\text{R}^c)(\text{R}^d)$ ,  $(\text{PO}_3)^{2-}(\text{M}^+)_2$ ,  $\text{NE}^4\text{E}^5$ ,  $(\text{NE}^4\text{E}^5\text{E}^6)^+\text{X}^-$ ,  $\text{OR}^e$ ,  $\text{SR}^e$ ,  $(\text{CHR}^f\text{CH}_2\text{O})_y\text{R}^e$ ,  $(\text{CH}_2\text{NE}^4)_y\text{R}^e$ ,  $(\text{CH}_2\text{CH}_2\text{NE}^4)_y\text{R}^e$ , halogen, nitro, acyl and cyano, where
- $\text{R}^c$  and  $\text{R}^d$  are each identical or different radicals selected from alkyl, cycloalkyl, aryl and hetaryl,
- $\text{R}^e$ ,  $\text{E}^4$ ,  $\text{E}^5$ ,  $\text{E}^6$  are each identical or different radicals selected from hydrogen, alkyl, cycloalkyl, acyl, aryl and hetaryl,
- $\text{R}^f$  is hydrogen, methyl or ethyl,
- $\text{M}^+$  is one cation equivalent,
- $\text{X}^-$  is one anion equivalent and
- $y$  is an integer from 1 to 240.
20. (previously presented) A process as claimed in claim 8, wherein  $R^1$  and  $R^2$ , together with the phosphorus atom to which they are bonded, are each a 5- to 8-membered heterocycle which may optionally additionally be singly, doubly or triply fused with cycloalkyl, heterocycloalkyl, aryl or hetaryl, and the heterocycle and, where present, the fused groups may each independently bear one, two, three or four substituents which are selected from alkyl, cycloalkyl, heterocycloalkyl, aryl, hetaryl,  $\text{COOR}^c$ ,  $\text{COO}^-\text{M}^+$ ,  $\text{SO}_3\text{R}^c$ ,  $\text{SO}_3^-\text{M}^+$ ,  $\text{PO}_3(\text{R}^c)(\text{R}^d)$ ,  $(\text{PO}_3)^{2-}(\text{M}^+)_2$ ,  $\text{NE}^4\text{E}^5$ ,  $(\text{NE}^4\text{E}^5\text{E}^6)^+\text{X}^-$ ,  $\text{OR}^e$ ,  $\text{SR}^e$ ,  $(\text{CHR}^f\text{CH}_2\text{O})_y\text{R}^e$ ,  $(\text{CH}_2\text{NE}^4)_y\text{R}^e$ ,  $(\text{CH}_2\text{CH}_2\text{NE}^4)_y\text{R}^e$ , halogen, nitro, acyl and cyano, where
- $\text{R}^c$  and  $\text{R}^d$  are each identical or different radicals selected from alkyl, cycloalkyl, aryl and hetaryl,
- $\text{R}^e$ ,  $\text{E}^4$ ,  $\text{E}^5$ ,  $\text{E}^6$  are each identical or different radicals selected from hydrogen, alkyl, cycloalkyl, acyl, aryl and hetaryl,
- $\text{R}^f$  is hydrogen, methyl or ethyl,
- $\text{M}^+$  is one cation equivalent,
- $\text{X}^-$  is one anion equivalent and
- $y$  is an integer from 1 to 240.
21. (new) A process for hydroformylating compounds which contain at least one ethylenically unsaturated double bond by reacting said

compounds with carbon monoxide and hydrogen in the presence of a catalyst, wherein the catalyst comprises at least one complex of a metal of transition group VIII of the Periodic Table of the Elements having ligands which each have a phosphorus group and each have at least one functional group which is capable of forming intermolecular noncovalent bonds, and wherein said ligands of the complex are dimerized via intermolecular noncovalent bonds such that the distance between the phosphorus atoms of the dimerized ligands is at most 5 Å.